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Influence of the rotary and/or oscillatory reciprocating systems in the morphological changes of narrow and curved molar root canals anatomy

Influência dos sistemas rotatórios e/ou oscilatórios recíprocos nas alterações morfológicas anatômicas de canais radiculares atresiados e curvos

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Resumo

Objetivo: Esse estudo avaliou quatro sistemas endodônticos mecanizados, ProTaper Universal, K3 Endo, Twisted file, (rotatórios) e Endo – Eze TiLOS(oscilatório) para verificar e medir as alterações na anatomia original do canal radicular e desvios nos terços cervical,médio e apical. **Material e método**: Foram utilizadas 60 raízes mésio-vestibulares de molares inferiores extraídos de humanos para coleta de medições de ângulos e classificação de Schneider. Os espécimes foram incluídos em resina de Éster vinil e montadas em muflas de Teflon, seccionadas transversalmente nos terços cervical,médio e apical para posterior fotografia usando-se câmera digital Cyber Shot DSC-TX10,acoplada à um microscópio 3101XY DFVasconcelos com 40× de aumento para se mensurar a àrea da secção anatômica transversal do canal radicular utilizando o programa AutoCAD 2008, comparando as àreas pré e pós instrumentação. Todos os espécimes ajustados na mufla foram radiografados de maneira padronizada para permitir a avaliação do ângulo de Schneider pré e pós-instrumentação.Uma vez coletados os dados,os mesmos foram comparados estatisticamente usando-se o programa BioEstat 5.0. **Resultado**: A análise dos resultados mostrou que no terço cervical os sistemas rotatórios foram mais eficazes que o sistema oscilatório Endo-Eze TiLOS,com diferenças estatisticamente significantes ($p \leq 0{,}05$). As alterações anatômicas relativas ao desvio nos terços apical e médio foram similares, mas apicalmente o sistema ProTaper promoveu mais desvios quando se avaliou o ângulo de Schneider pré e pós instrumentação ($p \leq 0{,}05$). **Conclusão**: Utilizando-se a alteração do ângulo de Schneider e a diferença entre área dentinária inicial (antes do preparo) e final (pós-preparo), concluiu-se que todos os sistemas causaram desvio na anatomia original do canal radicular.

Descritores: Tratamento de canal radicular; instrumentação; endodontia.

Abstract

Objective: This study evaluated four mechanized Endodontic systems, ProTaper Universal, K3 Endo, Twisted file (rotary) and the oscillatory reciprocating system Endo – Eze TiLOS, in order to verify and measure alterations in original anatomy with deviations at cervical, medium and apical root canal thirds. **Material and method**: It was used MB root canals of 60 extract human lower molars, to produce a line of severe angles, according to the classification of Schneider. Samples were included in Ester vinyl resin, mounted in the Teflon Furnace, transversally sectioned at the cervical, middle and apical thirds, which were subsequently photographed using a digital camera Cyber Shot DSC-TX10,attached to an operating microscope 3101XY DFVasconcelos with 40× magnification in order to measure the anatomical transversal area of the root canal, using the software AutoCAD 2008, comparing pre and post-instrumentation. All samples assembled in the Furnace also were submitted to x-ray in a standardized way to enable the comparison of the angle of Schneider pre-and post-instrumentation. Once collected the data, they were compared statistically using the program BioEstat 5.0. **Result**: The analysis of the results showed that in the cervical third, rotary systems were more effective than Endo-Eze TiLOS System with statistically significant differences (p ≤ 0,05). Apical and middle third changes in anatomy were similar, but apically, the ProTaper system caused more deviations when comparing the angle of Schneider,and areas before and after instrumentation(p ≤ 0,05). **Conclusion**: It was concluded that all the systems caused alteration in the original anatomy of the root canal when parameters as angle of Schneider and areas before and after preparation were used.

Descriptors: Root canal therapy; instrumentation; endodontics.

INTRODUCTION

Endodontics is science that embodies etiology, diagnosis, prevention, and treatment of apical periodontitis and its repercussion in the organism[1]. Apical Periodontitis is the disease that endodontists spend most of their practicing lives treating. Understanding of the pathogenesis and microbiology of this disease must be a prerequisite to outcome[2]. Absence of root canal infection after root canal preparation and filling contributes with treatment success of teeth with apical periodontitis[3].

Mechanical preparation plays a key role in this context by physically removing infected dentin and facilitating the access of irrigant solutions to the root canal system, mainly the apical critical curved area. The instrumentation of this critical area with instruments with larger sizes reduces infection more than apical instrumentation with small diameter instruments. The use of instruments with large diameters is difficult and requires the pre-enlargement of the root canal in the cervical and middle thirds, eliminating all the interferences, and may drive to procedural errors[4], like the transportation of the root canal. In order to minimize the risk of deformation of the root canal and transport of the apical portion during biomechanical preparation, a large number and options of techniques for instrumentation of root canals have been proposed.

Due to its high elasticity and flexibility, NiTi instruments can maintain a constant central position in the main canal, specially in the curved area, reducing apical transportation[5]. The kinematic of use of these instruments is also an important aspect to be considered, once reciprocating movement promotes an extended cyclic fatigue life in comparison with conventional rotation, that constantly leads to the fracture of the file[6]. Therefore, the goal of this study was to assess the occurrence and measurement of root canal area, before and after instrumentation, in the 3 anatomical thirds, and apical transportation using Schneider[7] method, using as sample, the mesiobuccal root canals of lower molars, comparing 3 standard rotary systems (Protaper Universal, K3 Endo, Twisted File) and the oscillatory reciprocating TiLOS System.

MATERIAL AND METHODS

It was selected 60 human first and second molars with separated root canals, extracted due advanced periodontal disease and/or tooth extensive decay, obtained through donations from dentists in the city of Maceió/AL Brazil. The teeth were stored in containers with 10% formalin until experiment started. They were cleaned with periodontal curettes to remove the organic debris and calculus, washed and sterilized in an autoclave. The radiographic examination was performed with periapical film in ortho-position radial, using a positioner (HR Indusbello-Plus – Indusbello Ind. e Com. Ltda, Londrina, Brasil) developed for this purpose. A wax #7 (Newwax – Technew Com Ind Ltda, Brazil) was used to stabilize the tooth on the platform, This way, all teeth were placed in the same distance from the cone and radiographic apparatus, in the same position in relation to the radiographic film. It was discarded all teeth with root calcification, root canal treatments, incomplete root formation, open apex and mesiobuccal root curvature higher than 20 degrees (according to Schneider classification of 1971). The length of all evaluated teeth ranged from 18 to 24 mm. The 60 teeth were divided randomly in 4 experimental groups of 15 teeth each. The initial values of the angle of Schneider were recorded for later comparison. For the inclusion of the teeth in resin, a muffle was confectioned in Teflon with three grooves of 2 mm deep on its inner the face, on both sides of the muffle. Aiming to guide the positioning of the resin block in the same position, the two parts of the muffle have the aid of two guide pins and two screws. The teeth were fastened to the top of the muffle with plastic glue SCOTCH FLEX (3M do BRASIL, Sumaré/SP) always taking care that the root apex touched the bottom base of the muffle. Once centralized, the muffle was filled with vinyl ester resin DERAKANE-470 (Dow Chemical Company-USA), resulting in a resin block. After the complete polymerization of the resin, the blocks were removed from the muffle and brought to a cutting machine Expec. (Gerber Cuttinhg-EUA). A diamond disk 0.15 mm thick cut transversely at 3 and 8 mm counted from the bottom of the resin block. To adapt the resin block in the cutting machine, a device was mounted using silicone Cloning (DFL S.P. Brazil).

Three cross sections were then obtained and were denominated, apical, medium and cervical. Images of the sections were done using Sony Cyber Shot digital camera with a DF Vasconcelos operatory microscope, with 40× magnification. The obtained images were transferred to the software AutoCAD 2008, and the initial and final mesial root canal areas were measured and statistically compared (Figure 1).

RESULT

1. *Angle of Schneider*

It can be observed in Figure 2, representative of the average of degree before and after the instrumentation, which all systems promote a rectification in the root canal and consequently changes in the curvature degrees. In all groups was verified also a decrease in the curvature degree.

The obtained values in degrees, before and after the instrumentation, of each system were submitted to analysis of variance of repeated measures (ANOVA) with 5% of significance level (Table 1).

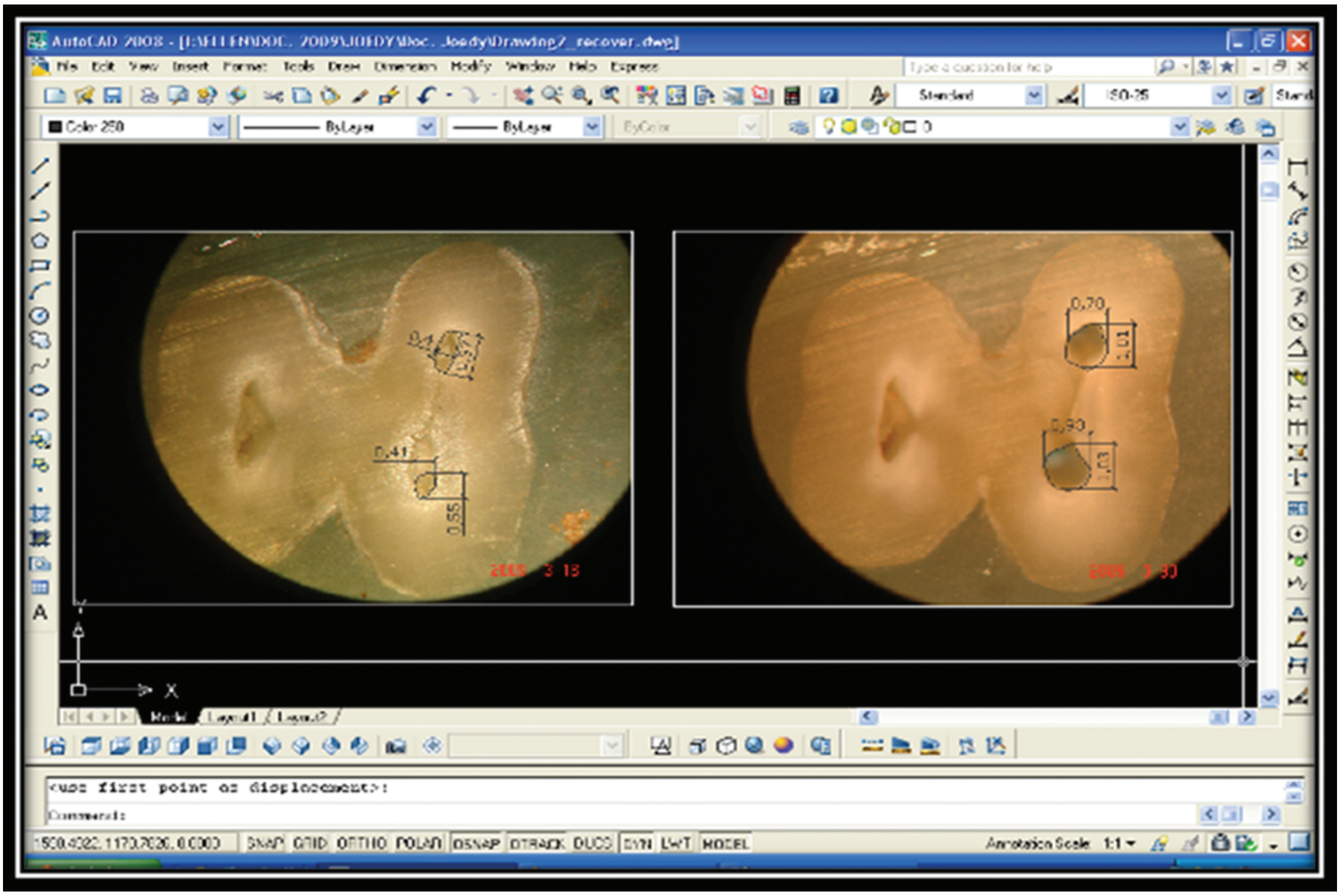

Figure 1. Measuring of the mesial root canals areas using the software AutoCAD 2008.

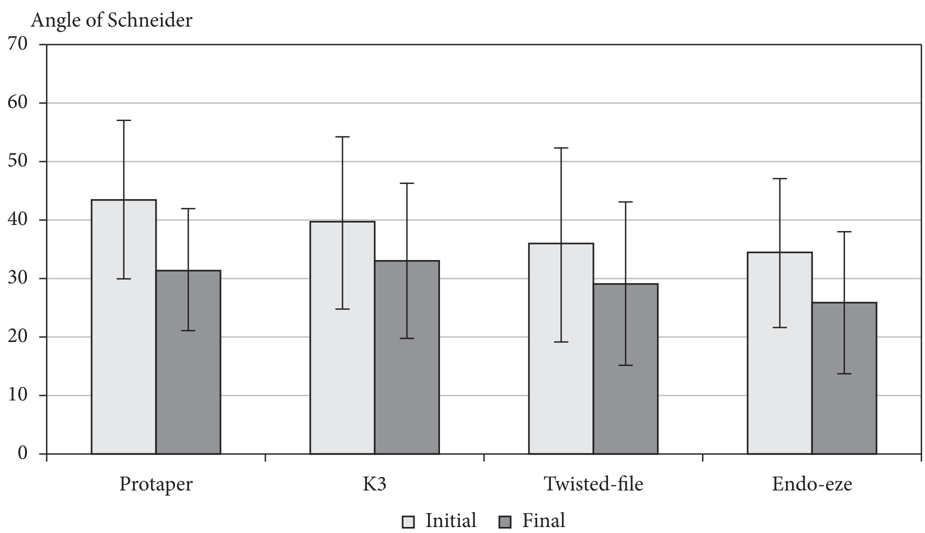

Figure 2. Average of the initial and final curvature degrees.

Table 1. Averages, standard deviation and value of p of the analyze of variance of the Protaper system

System	Average and deviation after PQM	Average and deviation before PQM	Test t - p
Protaper Universal	43.64 ± 13.52	31.47 ± 10.57	0.0137
K3 Endo	39.50 ± 14.78	33.14 ± 13.24	0.2399
Twisted File	36.00 ± 16.62	29.29 ± 13.97	0.2568
Endo-Eze	34.43 ± 12.77	26.07 ± 12.14	0.0844

It can be observed that among the tested systems that only the instrumentation with Protaper Universal promoted significant change in the curvature degree of the root canal, showing statistically significant difference ($p \leq 0{,}05$) between the initial and final values of the angle of Schneider.

The other systems maintained the original standards with minimum change in the root canal curvature, not presenting statistically significant difference ($p \geq 0.05$).

2. *Root Canal Area*

The evaluation of the effect of the used system, rotary or oscillating, over the canal area was perform by the coefficient between the final areas after the instrumentation and the initial area.

CERVICAL THIRD

The Figure 3 represents the average of the obtained coefficient between the area before and after the instrumentation in the cervical third. It can be observed that the three rotary systems provided the highest increase of the root canal area in the cervical third when comparing with oscillating system.

When performed the F test of the variance analysis, with 5% of significance level, it established that the G1, G2 and G3 groups statistically differentiate of the Group 4 ($p < 0{,}05$), however, not presenting significant difference between itself (Table 2).

MEDIUM THIRD

The Protaper system showed greater area of enlargement of the root canal, followed by the K3 Endo, Twisted File system and the EndoEze TiLOS. (Figure 4).

However, the F test of the variance analysis does not presented statistically significant difference ($p > 0.05$) between the groups as the average of the medium third area (Table 3).

APICAL THIRD

The K3 Endo system presented higher average of enlargement of the root canal, followed by the Protaper Universal system, Twisted File and EndoEze TiLOS (Figure 5).

The F test of the variance analysis, with 5% of level of significance does not showed statistically significant difference ($p > 0.05$) between the groups as the average of the apical third area (Table 4).

DISCUSSION

NiTi instruments are used in Endodontics since 1992. Since then, a lot of problems regarding fracture, deviation, excessive enlargement that weaken teeth, foraminal and apical transportation and iatrogenic changes in the original anatomy of the root canals started to be evident, specially narrow and curved canals. All these problems compromise the success of the endodontic therapy.

In this study it was evaluated mesial canals of lower molars, once these canals are representative of this kind of anatomy, are very difficult to prepare and became a huge challenge for mechanized instrumentation[8-20].

The obtained results presented statistic differences between the different kinematics(rotary or oscillating)in relation to the

Table 2. Averages and standard deviations of the area in cervical third

Groups	Averages of the values in mm^2
Protaper	0.61 ± 0.22 a
K3 Endo	0.60 ± 0.32 a
Twisted File	0.61 ± 0.28 a
Endo - Eze	0.29 ± 0.13 b

Averages accompany with different letters indicate statistically significant difference in the level of 5%.

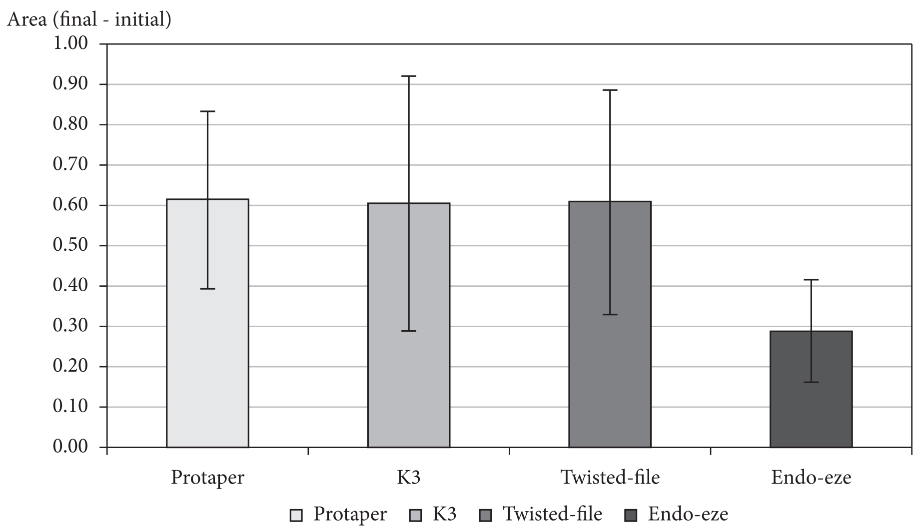

Figure 3. Averages and standard deviation of the averages of the obtained quotient between the final and initial areas in the cervical third.

root canal instrumentation area. The rotary systems presented more effective wears in the cervical third, when compared to the oscillatory system .Deplazes et al.[21] (2001) founded, in the same third, equivalent increase wears. In spite of the positive effect of this enlargement, once it makes an easier access to the apical third, it can result in weakening the tooth structure, and/or causing lateral root perforation in risk areas(the distal face of mesial canals in lower molars for exemple). Gluskin et al.[22] (2001), comparing the effects of the manual instrumentation associate to Gates-Glidden bur with the GT rotation system, founded significant differences in the remaining thickness of dentin in risk areas. They concluded that iatrogenic wears weaken the tooth a lot, in a tentative to create an appropriate root access.Thus, it is preferable the use of flexible instruments with bigger taper and diameter to perform it. Similar findings were also verified by Bergmans et al.[23] (2002) comparing the Lightspeed and GT systems.

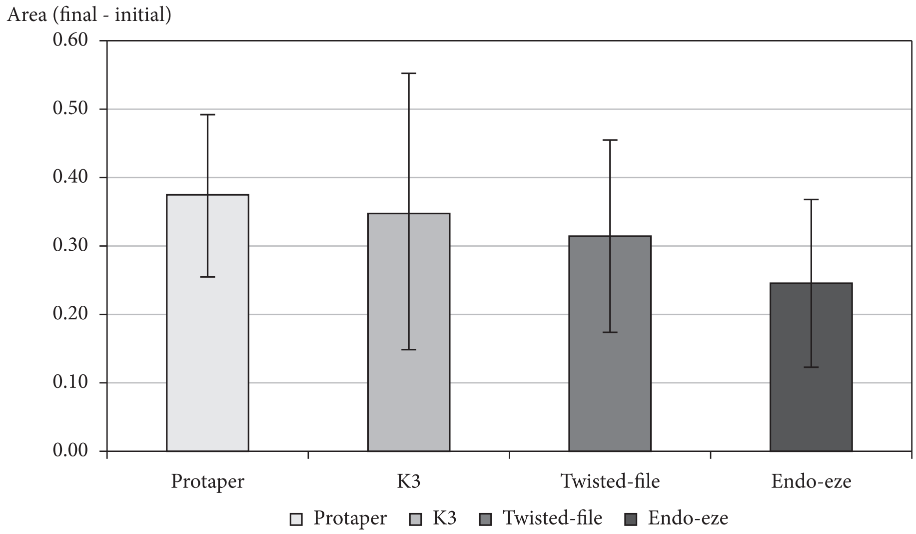

Figure 4. Averages and standard deviation of the averages of the obtained quotient between the final and initial medium third areas.

Table 3. F Testof the variance analysis to comparison of the area averages between the groups

Variation sources	Freedom degrees	Medium square	F	p-value
Mistake treatments	3 46	0.037 0.023	1.65	0.188

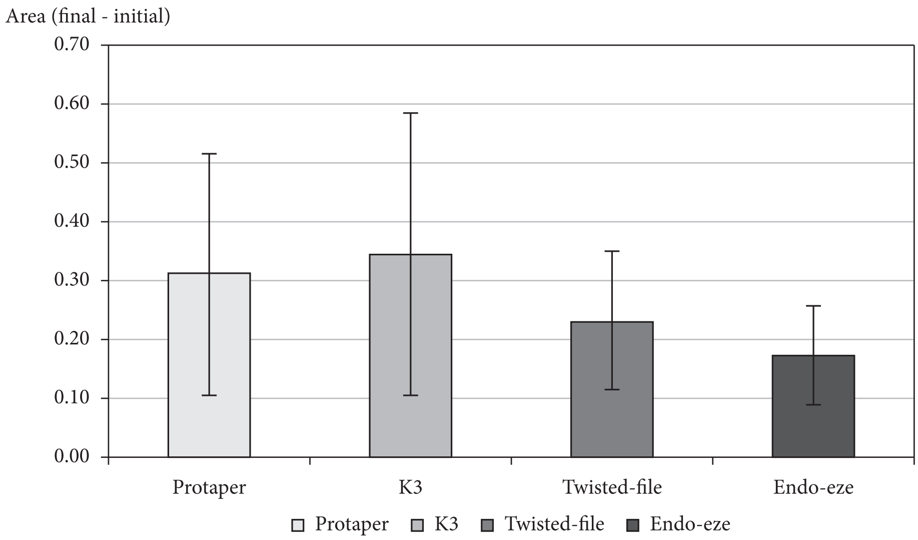

Figure 5. Averages and standard deviation of the averages of the obtained quotient between the final and initial areas in the apical third.

Table 4. F test of variance analysis to comparison of the area averages between the groups

Variation sources	Freedom degrees	Medium square	F	p-value
Mistake treatments	3 46	0.068 0.030	2.25	0.0931

According to the results the EndoEze TiLOS oscillatory system promoted enlargement and wear of this third with a higher safety, because of its low wear, once it uses instruments with lower taper and metallic mass in the cervical third. In the medium and apical thirds the systems showed similar performance results, going against Heck[24] (2005) studies that evaluated the effect of three instrumentation techniques: hybrid, step back and rotary in the apical third of lower molars mesial canals. The author concluded that the compared techniques did not present a similar performance in the apical third, since the diameter values in the apical third weren't similar. However, the results of this research confirm the studies of Veltry et al.[25] (2004) and Ozgur Uyanik et al.[26] (2006), no statistically difference between different techniques was found.

Bergmans et al.[23] (2002) compared the influence of the variable taper of the Protaper Universal system with the constant taper influence of the K3 Endo system in the preparation of the mesial canals of lower molars. They observed that the Protaper system instruments promotes a centering apical prepare, respecting the root canal axis. However, these instruments promote the displacement of the preparation area, in cervical third, dangerous for the risk area, while the K3 Endo system instruments makes a displacement run into the safety area. However, in the cervical third wear area does not have evidences of differences between the Protaper and K3 Endo systems, the present study found different results from the studies of Bergmans, because the Protaper system promoted more changes in the apical third, with higher incidence of deviation. Rasquin et al.[27] (2007) compared Endo Eze and Race systems, and found similar results to the ones we found with EndoEze, with more centered preparation, preserving tooth structures. Zanin[28] (2006) also found centered preparation with minimally invasive wears. These studies were opposite to founding from those by Camargo[29] (2004) and Paque et al.[30] (2005), that founded high levels of deviation.

The Twisted File rotary system, when compared to the Protaper and K3 Endo systems, presented excellent results as the maintenance of the canal anatomy and low levels of apical deviation. Studies of Kariem, Elmallah[31] (2011) demonstrated that the Twisted File system present better results when compared the K3 Endo system. This fact was not confirmed in the present study, with all systems showing similar results. They stated that Twisted File instruments transported the least root canal preparations, with a significant difference when compared with ProTaper group. They justified their results in accordance to the manufacturing of TF with twisting a Nickel Titanium wire, resulting in more flexibility than NiTi grounded instruments. Fayyad, Elgendy[32] (2011) affirmed that the non-ISO progressive taper in the ProTaper system shows a higher cutting ability with selective areas of cutting.

CONCLUSION

Based in the obtained evidences in the present study it can established that the systems showed optimum results in the root canal preparation, maintaining the original root canal anatomy, with exception of the Protaper system, which showed higher transportations at apical third. However, it is important to consider that the scarce literature comparing the continuous and alternate systems, drives researchers towards new works using also different methodologies and protocols

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CONFLICTS OF INTERESTS

The authors declare no conflicts of interest.

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